BC
Ministry of Environment

WESTERN CANADA LRTAP ACTIVITIES

ANNUAL REPORT 1983

A report on monitoring and research studies related to acid rain and long-range transport of atmospheric pollutants in western Canada

Environment Canada
Environnement Canada

Alberta ENVIRONMENT

Saskatchewan Environment

Northwest Territories

Manitoba Environment and Workplace Safety and Health

84- 4079 /

WESTERN CANADA LRTAP ACTIVITIES

ANNUAL REPORT 1983

A report on monitoring and research studies related to acid rain and long-range transport of atmospheric pollutants in western Canada

TECHNICAL COMMITTEE MEMBERS

Mr. L.J. Lechner

Saskatchewan Environment
Air Pollution Control
5th Floor
1855 Victoria Avenue
Regina, SK
S4P 3V5
(306) 565-6195

Mr. A.S. Mann
(Secretary)

Environment Canada
Atmospheric Environment Service
Argyll Centre
6325 - 103 Street
Edmonton, AB
T6H 5H6
(403) 437-1250

Mr. M. Morelli

Manitoba Environment and Workplace
Safety and Health
Environmental Standards and Studies
Box 7, Building 2
139 Tuxedo Avenue
Winnipeg, MB
R3N 0H6
(204) 945-7032

Dr. H.S. Sandhu

Alberta Environment
Research Management Division
14th Floor, Standard Life Centre
10405 Jasper Avenue
Edmonton, AB
T5J 3N4
(403) 422-2071

Mr. M. Smith

Pollution Control Division
Renewable Resources
Government of the Northwest Territories
Yellowknife, Northwest Territories
(403) 873-7654

Dr. R.G. Wilson
(Chairman)

British Columbia Environment
Waste Management Branch
810 Blanshard Street
Victoria, B.C.
V8V 1X5
(604) 387-4321

MAP OF WESTERN CANADA

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	BRITISH COLUMBIA	2
3.	ALBERTA	6
4.	SASKATCHEWAN	14
5.	MANITOBA	17
6.	NORTHWEST TERRITORIES	20
7.	ENVIRONMENT CANADA	21
8.	FISHERIES AND OCEANS CANADA	26
9.	JOINTLY MANAGED ACTIVITIES	27
10.	INDUSTRY AND INSTITUTION ACTIVITIES	29
11.	ADDRESSES FOR FURTHER INFORMATION	36

1. INTRODUCTION

Deputy ministers and senior officials from Environment Canada and the environment departments of British Columbia, Alberta, Saskatchewan and Manitoba met in Edmonton on 4 September, 1980, to review available information on acid rain and long-range transport of air pollutants (LRTAP) in western Canada. At that time, they concluded that acidic deposition was not a serious problem in the West. With an increase in industrial activity in western Canada and the western United States, the deputy ministers subsequently agreed that continued vigilance against acid rain and LRTAP was indeed warranted. They agreed to establish a Consultative Committee of deputy ministers and a Technical Committee of senior officials from the four western provinces and Environment Canada to coordinate monitoring, research and other activities on acid rain and LRTAP.

In December, 1982, the deputy ministers of the participating agencies, which by then included representation from the Northwest Territories, signed an agreement for a three-year research program covering the period 1982 to 1985. The program's objectives included identifying current conditions in western Canada, and providing the information necessary for the agencies to develop appropriate management strategies. Six program priorities were established, as follows:

(1) maps of aquatic sensitivity
(2) maps of soil and geology sensitivity
(3) monitoring of background precipitation
(4) modelling of atmospheric deposition patterns
(5) inventories of sulphur dioxide and nitrogen oxides, and
(6) monitoring of surface waters and soils in data sparse areas.

This document, the third annual report of the Technical Committee, summarizes monitoring and research activities on acid rain and LRTAP conducted in western Canada during 1983. The reader will recognize the significant extent to which all of the priority areas are being addressed in this the second year of the three-year agreement discussed above. In addition to the programs of the various government agencies, identified in Sections 1 through 9 of this report, we have summarized, in Section 10, a variety of projects in industry, universities, and research institutes which have come to our attention. Additional information on any of the projects described in the report can be obtained by contacting either the Technical Committee members listed on page ii, or the agencies listed in Section 11. The Technical Committee also would be very pleased to learn of additional projects not listed here.

2. BRITISH COLUMBIA

2.1 EMISSIONS AND CONTROL TECHNOLOGY

Emission Inventory
British Columbia Environment completed a sulphur dioxide inventory for 1982. An inventory for nitrogen oxides emissions will be initiated early in 1984.

Report: A report entitled "Sulphur Dioxide Emission Inventory of British Columbia for 1982" is available from the Waste Management Branch, British Columbia Environment.

2.2 AIR QUALITY AND DEPOSITION

Precipitation Acidity in British Columbia
In 1983 British Columbia Environment installed five automatic precipitation monitoring stations for measurements of precipitation chemistry. These stations are now in operation and are located in Dawson Creek, Kitimat, Smithers, Cranbrook and Victoria. A sixth station is planned to begin operation in Kamloops in early 1984.

Results: Data summaries will be available from the Waste Management Branch, British Columbia Environment.

Monitoring and Quality Control
British Columbia Environment has continued to participate in national inter-laboratory comparisons, and in the work of the national Quality Assurance Subgroup.

Report: A new report entitled "Chemical Analysis of Acid Precipitation: pH and Acidity" is available from the Environmental Laboratory, British Columbia Environment.

Wet Sulphate Deposition Criteria
British Columbia Environment is reviewing all available information on deposition rates and the associated impacts on elements of the environment.

Results: A report is anticipated from the Waste Management Branch, British Columbia Environment.

Snowpack Sampling in South Central British Columbia
The snowpack chemistry program initiated in 1980/81 was continued in the winter of 1982/83 by British Columbia Environment. This marks the third year that snow core samples have been collected from

the sixteen sites. Samples were analyzed for pH, total acidity and strong acidity, sulphate, nitrate, chloride, fluoride, phosphate, sodium, potassium, calcium, magnesium, ammonium and aluminum. This is an ongoing project.

Report: Data are available from the Waste Management Branch, British Columbia Environment.

2.3 SURFACE WATERS

Surface Water Sampling
British Columbia Environment collected surface water samples at about 50 lakes during 1983 which had not been sampled previously. The data were collected to provide background information for lake sensitivity mapping programs. To date, lake data have been collected on about 35 lakes in the Province north from 56°N, a remote area identified in preliminary lake sensitivity maps as having had no data collected. Samples were analyzed at a minimum for pH, calcium, magnesium, alkalinity, and aluminum. In addition, associated ions, metals, nutrients and solids measurements were made at most of these sites.

Results: Data available through Water Management Branch, British Columbia Environment.

Lake Sensitivity Mapping
British Columbia Environment prepared preliminary lake sensitivity maps for the Province in 1982: one based upon calcium data; one based upon alkalinity data; and one which compiled sensitivity classifications from both the calcium and alkalinity maps. In addition, a map based upon pH showing present lake acidity was prepared. All maps were based upon data collected from 1977 through 1981 following the criteria outlined by the Coordinating Committee on Surface Waters.

Results: Copies of these preliminary maps are available through Waste Management Branch, British Columbia Environment.

2.4 SOILS AND GEOLOGY

Sensitivity Mapping
Preparation of a preliminary 1:2 000 000 Soil Sensitivity to Acid Precipitation map with accompanying report was completed in 1983. However,

preparation of this map and report preceded agreements on methodology and criteria for terrestrial sensitivity mapping in Western Canada. Factors used for rating soil sensitivity included exchangeable bases, cation exchange capacity, texture, soil family, particle size, and pH. Rating of more than one-half the province required inference of properties from very broad scale soil, terrain, and bedrock maps.

Following meetings of the Soils and Geology Sensitivity Mapping Task Group on June 27 and 28, 1983, further sensitivity mapping is being undertaken. The intention is to conform to methodology and sensitivity classification criteria agreed to for Western Canada, at the meetings. Mapping scale will still be 1:2 000 000 and the previously used soil map of the province will still be used as a base. Two sensitivity interpretations are intended: potential of soils and geology to reduce acidity inputs to aquatic systems, and forest and agricultural productivity sensitivity.

Results: The initial 1:2 000 000 soil sensitivity map and report have been completed but have received only limited distribution because of the forthcoming new mapping. The revised sensitivity mapping is to be completed in draft in the spring of 1984. For information contact the Surveys and Resource Mapping Branch, British Columbia Environment.

Buffer Capacity of Some British Columbia Soils

Titrations with acid of over 200 selected soil samples from various parts of British Columbia have been completed in the laboratory. Several estimates of buffering capacity were taken from the titration curves. These estimates were statistically analysed in relation to other, previously determined soil chemical and physical characteristics. Relationships have been derived for all samples as well as for samples grouped according to several criteria including geographic area, soil horizon type, and initial soil pH.

Results: A draft report is in preparation. For information, contact the Surveys and Resource Mapping Branch, British Columbia Environment.

2.5 VEGETATION SENSITIVITY

Vegetation Sensitivity
British Columbia Environment has developed a crop sensitivity index to reflect the relative amount of time a crop could be exposed to acidic input before impacting on crop production. The index is based on the capacity of the soil to buffer against acid input, and was developed for application in the Lower Fraser Valley where vegetable and horticultural production is a dominant land use. In addition, the potential acid sensitivity of vegetation has been examined for the Peace River and Cariboo-North Thompson Regions.

Report: A report will be available from the Surveys and Resource Mapping Branch, British Columbia Environment.

Lichen Response to Sulphur Dioxide
Lichen sampling was repeated after three years of exposure in the spring of 1983 for twenty sites in the vicinity of a natural gas processing plant in Chetwynd. The objective is to evaluate the possible effects of ambient sulphur dioxide on the lichens and to test the methodology being applied.

Results: For information on this ongoing project, contact the Surveys and Resource Mapping Branch, British Columbia Environment.

2.6 HEALTH

There are no monitoring programs or studies underway relative to health effects from acidic deposition.

3. ALBERTA

3.1 EMISSIONS AND CONTROL TECHNOLOGY

Industrial NO_x Emissions for Alberta 1977-1981
An inventory of oxides of nitrogen (NO_x) emission sources in Alberta will be given. Emission totals, both observed and licenced, for individual plants and industrial groups are included along with observed trends.

Report: A final report will be available early in 1984 from the Pollution Control Division, Alberta Environment.

Gaseous Emission Control Technology
A wide range of concepts/ processes for the control of acid gas emissions will be assessed and developed. Source industries such as gas processing, thermal power, oil sands, gas compression and waste incineration will be considered. The use of magnesium oxide to remove sulphur dioxide gas from a sour gas processing plant has been developed and successfully tested at bench-scale with a pilot-scale facility planned for 1984.

Report: A progress report will be available in 1984 from the Environmental Technology Wing, Alberta Environmental Centre.

3.2 AIR QUALITY AND DEPOSITION

Dry Deposition of Acid Forming Emissions in Alberta
The project will: (1) measure, on a continuous basis during the growing season, ambient concentrations of sulphur dioxide; and (2) collect integrated data on the quantity and quality of dry and wetfall particulate matter. The development and field testing of measurement techniques for the dry deposition of sulphur dioxide will be promoted and the subsequent dry deposition velocities derived. The project will provide information necessary to assess the total sulphur deposition occurring in the vicinity of an Athabasca Oil Sands plant and define the source-receptor relationships.

Report: An initial report will be prepared and made available in 1984 from the Research Management Division, Alberta Environment.

Measurement of Dry Deposition of Sulphur Dioxide in Alberta
The concentration gradient method will be used to measure the dry deposition velocity of sulphur dioxide (SO_2) to a barley crop. The project is

situated in the vicinity of a sour gas plant at Crossfield, Alberta. Relationships to the growth state of the receptor canopy and to meteorological conditions will be made.

Report: A report is available from the Pollution Control Division, Alberta Environment.

Airborne Pollution Measurement and Trajectory Analysis
Initiated in 1982 as a cooperative effort between Alberta Research Council and Alberta Environment, this project investigates the dispersion and transport of acid forming emissions from point source plumes in the oil sands area near Fort McMurray. The chemical transformation and removal rate of sulphur dioxide and oxides of nitrogen from the atmosphere by both clouds and precipitation will be determined.

Report: An interim report will be available in 1984 from the Research Management Division, Alberta Environment.

Chemistry of Winter Precipitation in the Oil Sands Area
As an ongoing project since 1976, the accumulated snowpack in the Fort McMurray area has been extensively sampled and chemically analyzed. The objective is to quantify the total ionic and particulate loading and to qualitatively assess the spatial distribution of pollutant deposition. This information will provide baseline data to assess the impact of future industrial developments in the area. Developmental work is being implemented which will investigate: (1) the chemical composition of meltwater; and (2) the fractionation of ions during snowmelt.

Report: A summary report is in preparation and may be available by the end of 1984 from the Research Management Division, Alberta Environment.

Chemistry of Summer Precipitation in the Oil Sands Area
Rainfall has been collected on an event basis in the Fort McMurray Oil Sands area since 1976. The chemical composition of the samples is evaluated to determine the amount and distribution of wetfall deposition. Objectives of the study are: (1) to quantify changes in the input rate of atmospheric trace substances; (2) to establish a data base for the identification of trends in the chemical composition of the

precipitation; and (3) to monitor the level of background pollutants.

Report: A preliminary report can be obtained from the Research Management Division, Alberta Environment.

Guideline for Estimating Sulphur Deposition in the Vicinity of Point Source Emissions

A computer model is used to provide a guideline on calculating the seasonal and annual wet and dry sulphur deposition in the vicinity (100 km) of a point source. Inputs include climatological data and the STAR data set. Output is seasonal and annual sulphur dioxide concentrations and wet/dry sulphur depositions as a function of direction and distance from the source.

Report: A model User's Guide is available and model run maps and tabulations can be provided by the Pollution Control Division, Alberta Environment.

Precipitation Quality Data Summary

The chemical composition of precipitation is monitored at several permanent sites in Alberta. The objective of the project is to detect significant changes resulting from industrialization and to provide an historical data base. A five year summary is currently in preparation.

Report: Data reports are produced annually and available from the Pollution Control Division, Alberta Environment.

Air Quality Data Acquisition for Research on Permanent Sample Plots

An air quality monitoring station was established in the vicinity of a biological monitoring plot in the oil sands area near Fort McMurray. The station will measure on a continuous basis both meteorological data and ambient concentrations of acid forming gases which will be beneficial in assessing the response of terrestrial ecosystems to pollution episodes. The data generated will be used to develop numerical models for interfacing atmospheric/air quality data to receptor response measurements.

Report: An initial report will be available in 1984 from the Research Management Division, Alberta Environment.

3.3 SURFACE WATERS

Aquatic Sensitivity Mapping: Phase II
Phase I of this project involved establishing the criteria for sensitivity of surface waters in Alberta to deposition of acid forming emissions. Preliminary sensitivity maps were prepared. The second phase will involve updating the sensitivity maps using current monitoring data which addresses any gaps previously identified. Parameters of concern include: pH, calcium, magnesium, alkalinity and total dissolved solids.

Report: A Phase I report will be available early in 1984 and the Phase II report is to be completed by mid-1984. Both will be available from the Research Management Division, Alberta Environment.

3.4 SOILS AND GEOLOGY

Effects of Deposition of Acid Forming Susbstances on Organic Matter Decomposition and Microbial Activity
Organic matter transformations in the litter layer of jackpine-woodland ecosystems under different levels of impact by acid forming substances will be investigated. Sampling of litter fall, decomposition rates, biological activity and total microbial biomass will be done. Major reactions in carbon (energy) flow are to be measured and correlated with the impact of acid forming substances.

Report: This is an ongoing project with annual reports due in April of each year and available from the Research Management Division, Alberta Environment.

Effects of Deposition of Acid Forming Substances on Nutrient Cycling in a Forest Ecosystem
The effects of deposition of acid forming substances on: (1) nutrient release from decomposing litter; (2) distribution and leaching characteristics of key nutrients in the litter/soil system; and (3) the uptake of nutrients by mycorrhizal and non-mycorrhizal jackpine seedlings will be studied.

Report: This is an ongoing project with annual reports due each year in April and available from the Research Management Division, Alberta Environment.

Sensitivity of Soils in Alberta to Acid Additions
In an attempt to map soils on

the basis of their sensitivity to acidification, the project will investigate: (1) whether soil survey information can be used to assess relative sensitivity of soils; and (2) what levels of acid addition can the soils tolerate before their productivity is impaired.

Report: An interim report will be available late 1984 from the Earth Sciences Division, Alberta Environment.

Long Term Measurement of the Acidification of Non-Cultivated Soils in Alberta
A wide range of physical and chemical characteristics of soils has been studied to determine which parameters are best for indicating the sensitivity of soils to acidification. This information will be used to monitor the long term acidification of non-cultivated soils in Alberta where deposition of acid precursors is high.

Report: A brief synthesis of procedures and results will be available in 1984 from the Earth Sciences Division, Alberta Environment.

3.5 VEGETATION

Atmosphere-Biosphere Interface: Numerical Model Generation Probability Analysis and Experimental Design
The project will develop a computerized numerical model for integrating chronic air pollutant exposures to an agricultural crop response. Correlations exceeding 0.9 have been obtained.

Report: A final report has been received and will be available in the spring of 1984 from the Research Management Division, Alberta Environment.

Atmosphere-Biosphere Interface: Computerized Numerical Model for Lodgepole Pine Response to Chronic Atmospheric SO_2 Exposure; Analytical Design of Plant Response to SO_2 Exposure in Alberta (A Critical Review)
As an extension of an earlier interface project dealing with an agricultural crop, this study will involve Lodgepole Pine. A mathematical model will be derived and tested to determine the relationship between chronic atmospheric sulfur dioxide (SO_2) released by sour gas plants and tree growth responses.

Report: A final report will be available in the fall of 1984 from the Research Management Division, Alberta Environment.

Protection of the Biotic Environment

The project is designed to distinguish the effects of anthropogenic from natural emissions on the forest ecosystem. Morphologic and growth responses in Aspen stands are being studied to determine if pollution effects can be identified and quantified.

Report: A final report will be available in 1984 from the Research Management Division, Alberta Environment.

Nutrient Redistribution in Jackpine as an Indication of Acid Deposition Stress

The feasibility of using non-destructive analytical methods to detect changes in tree wood chemistry is to be examined. Tree cores will be analyzed for temporal nutrient changes and related to the emissions of oil sands plants in the Fort McMurray area.

Report: A final report will be available in the fall of 1984 from the Research Management Division, Alberta Environment.

The Response of Vegetational Communities to Aerial Emissions

The short and long term response of vegetational communities to aerial emissions is being investigated. Single annual surveys at several sites were done initially; however, numerous observations throughout the growth cycle are now made at four selected sites. A precise determination of phenological parameters will be made to allow correlation with continuous air quality data.

Report: Two initial reports on baseline states are available from the Research Management Division, Alberta Environment.

Impacts of Air Pollutant Mixtures on Forest Vegetation and Soils

The study is designed to use both laboratory and field investigations to identify and quantify forest tree responses to single and multiple exposures of acid forming pollutants. For the Athabasca Oil Sands area, a predictive capability for changes in forest soils and vegetation will be made. Both current and future rates of

pollution deposition are considered.

Report: Interim reports are available from the Research Management Division, Alberta Environment.

Physiological Effects of Low Concentrations of NO_x on Alberta Plant Species

The sensitivity of selected plant species to injury by low concentrations of nitric oxide (NO) and/or nitrogen dioxide (NO_2) is studied. The ability of certain plant species to acclimate to these low concentrations is also investigated. Mixtures of nitrogen oxides (NO_x)/sulphur dioxide (SO_2) and nitrogen oxides/hydrogen sulphide (H_2S) are also under consideration.

Report: A final report is due early in 1984 and will be available from the Research Management Division, Alberta Environment.

The Effect of SO_2 Emitted from a Sour Gas Plant on the Development of Endomycorrhizas (VA) on Phleum pratense L

The physiological effects of sulphur dioxide (SO_2) on Phleum practense L will be related to the subsequent effect on endomycorrhizas (VA) inhibiting the roots of this agriculturally important species. Laboratory fumigation and field site experiments over a two year period will be used to monitor the effects on mycorrhizal root infection, root biomass and root exudation.

Report: When completed, the final report will be available from the Research Management Division, Alberta Environment.

3.6 HEALTH

Health Effects of Sulphur-Containing Emissions (Inhalation Toxicology)

The program will examine, in vivo, the effects of acute, sub-acute and chronic inhalation exposures of hydrogen sulphide, sulphur dioxide, and other gases on laboratory rodents and other species. Studies of the toxic effects on animals and, by extrapolation, on man will be made. Standard and specialized biochemical, physiological, immunological and cellular toxicological assays of pulmonary toxicity will be developed. Expanded laboratory facilities are currently under construction.

Report: Initial publications can be obtained from the Toxicology Group,

Animal Sciences Wing,
Alberta Environmental
Centre.

Effects of Environmental Sulphur on Farm Animals

This study investigates the role of indirect exposure to sulphur-containing emissions on Alberta cattle specifically the incidence of certain reproductive and infectious diseases, reduced productivity and trace element nutritional deficiencies. The role of direct exposure to sulphur-containing emissions on the health and productivity of cattle is also under investigation.

Research is underway on ambient exposures, irregular symptomatic incidences and acute exposures in both laboratory and field studies.

Report: The published results and other reports of a pilot project are available from the Toxicology Group, Animal Sciences Wing, Alberta Environmental Centre.

4.1 EMISSIONS AND CONTROL TECHNOLOGY

Saskatchewan Air Emission Inventory of Sulphur Dioxide and Nitrogen Oxides
The inventory of sulphur dioxide and nitrogen oxides emissions has been updated for 1983. The inventory includes ten major source categories ranging from power generation and transportation to forest fires.

Report: A final report will be available in May, 1984, through the Air Pollution Control Branch, Saskatchewan Environment.

4.2 AIR QUALITY AND DEPOSITION

Poplar River Thermal Power Plant Ambient Air Monitoring Program
Saskatchewan Environment monitors sulphur dioxide and suspended particulates at one location, Coronach.

Results: Data summaries are available through the Air Pollution Control Branch, Saskatchewan Environment.

Snowpack Chemistry in Northern Saskatchewan
A snowpack chemistry study was conducted by the Saskatchewan Research Council in March, 1983. The study involved the collection of snow samples at 22 sites uniformly distributed throughout northern Saskatchewan. The samples were analyzed for pH, sulphate, nitrate, chloride, ammonium, alkalinity and metal ions scan.

Report: A report will be available in April, 1984, through the Air Pollution Control Branch, Saskatchewan Environment and the Saskatchewan Research Council.

Chemistry of Summer Precipitation in Northern Saskatchewan
Rainfall is collected, on an event basis, at five sites in northern Saskatchewan. Chemical analyses for sulphate, nitrate chloride, ammonium, potassium, calcium, sodium, magnesium, pH and a metal ions scan provide data for evaluation of deposition rates.

Result: Preliminary data are available through the Air Pollution Control Branch, Saskatchewan Environment.

4.3 SURFACE WATERS

Surface Water Sampling
Approximately 50 surface water stations in northern Saskatchewan are monitored. Forty of these are collected by industry at the

request of Saskatchewan Environment.

Results: Data summaries are available through the Water Pollution Control Branch, Saskatchewan Environment.

Lake Water Chemistry for Small Lakes in Northern Saskatchewan
A lake water chemistry study was conducted by the Saskatchewan Research Council in March, 1983. The study involved the collection of water samples at 25 sites uniformly distributed throughout northern Saskatchewan. The samples were analyzed at a minimum for pH, calcium, magnesium, alkalinity, and aluminum. In addition, associated ions, metals, nutrients and solids measurements were made at most sites.

Report: A report will be available in April, 1984, through the Air Pollution Control Branch, Saskatchewan Environment and the Saskatchewan Research Council.

Lake Sensitivity Mapping
Preliminary work is underway with respect to mapping lakes on the basis of their sensitivity to acidification. Existing data dating back to 1977 has been collected and documented. Preliminary lake sensitivity maps have been prepared for the province: one based upon calcium data, one based upon alkalinity data, one based upon pH data, and one which compiled sensitivity classifications from both calcium and alkalinity maps. All maps are based on the criteria outlined by the Coordinating Committee on Surface Waters.

Results: Copies of these maps are available through the Air Pollution Control Branch, Saskatchewan Environment.

4.4 SOILS AND GEOLOGY

Sensitivity Mapping
Maps of Saskatchewan depicting soils and geology sensitivity to acid precipitation have been prepared by the Saskatchewan Institute of Pedology. The maps are based on the criteria outlined by the Co-ordinating Committee on Soils and Geology Sensitivity Mapping.

Report: A report will be available in April, 1984 through the Air Pollution Control Branch, Saskatchewan Environment and the Saskatchewan Institute of Pedology.

4.5 VEGETATION

No specific monitoring activities or studies are underway with respect to vegetation response to acidic deposition.

4.6 HEALTH

No specific monitoring activities or studies are underway with respect to health effects from acidic deposition.

5. MANITOBA

5.1 EMISSIONS AND CONTROL TECHNOLOGY

No specific activities or studies are underway with respect to emissions and control technology.

5.2 AIR QUALITY AND DEPOSITION

Air Quality Monitoring in Northern Manitoba
Atmospheric sulphur dioxide is measured on a continuous basis downwind from the two major non-ferrous smelters at Flin Flon and Thompson. The network consists of two stations within the Flin Flon area and one in Thompson. Total reduced sulphur compounds are measured at one site near the MANFOR kraft pulp and paper mill at The Pas.

Results: Data summaries are available from Manitoba Environmental Management.

Precipitation Monitoring at Norway House and Island Lake.
Precipitation is sampled on a daily event basis at Norway House and Island Lake and analyzed for pH, conductance, acidity, sulphate, nitrate, chloride, calcium, ammonium, magnesium, sodium and potassium. Three additional monitoring sites (Gillam, Pointe du Bois, Brochet) are scheduled to become functional in January, 1984.

Results: Data summaries are available from Manitoba Environmental Management.

Snowpack Survey
A winter snowpack survey is being conducted within the boreal forest ecosystem surrounding the smelters in Flin Flon and Thompson. Seven sampling sites are located around Flin Flon and twelve near Thompson. At each site replicate samples are taken with a Mount Rose sampler and analyzed for pH, sulphate, zinc, lead, copper, nickel, iron, cadmium and arsenic. The snowpack survey includes 18 stations throughout the province. Samples are analyzed for pH, conductance, acidity, sulphate, nitrate, chloride, calcium, ammonium, magnesium, sodium and potassium.

Results: Data summaries are available through Manitoba Environmental Management.

5.3 SURFACE WATERS

Surface Water Sampling
Surface waters are monitored routinely at 27 locations north of the 53° parallel. Each site is visited six times per year.

South of the 53° parallel surface waters are monitored

routinely at 53 stations. Each site is visited monthly and samples are taken if water flow is present.

In addition, approximately 1400 sites, located within NTS map section 64C of Northern Manitoba, were sampled as a part of a Geochemical Reconnaissance Program operated jointly by the Manitoba Geological Services Branch and the Federal Government.

The chemical analyses of the samples were carried out by the Manitoba Environment.

Results: Data summaries are available through Manitoba Environmental Management.

5.4 SOILS AND GEOLOGY

There are no routine soils monitoring programs in progress. Some studies have been carried out jointly with Environment Canada. Terrestrial sensitivity mapping has been initiated in cooperation with other jurisdictions of Western Canada.

Results: Summaries of data are available through Manitoba Environmental Management and the Northern Forest Research Centre, Edmonton.

5.5 VEGETATION

There are no ongoing vegetation studies underway relative to acid rain. Some studies have been carried out jointly with Environment Canada.

Results: Summaries of data are available through Manitoba Environmental Management and the Northern Forest Research Centre, Edmonton.

5.6 HEALTH

Fluoride Levels in White Tail Deer

Monitoring on fluoride levels in bone tissue of white tail deer is carried out in the Lockport and Birds Hill area.

Results: This is an ongoing study; interim results are available through Manitoba Environmental Management.

Metals in Mammals

Metals such as arsenic, lead, zinc, cadmium, cobalt, manganese, nickel and chromium are surveyed in small mammals near the Thompson and Flin Flon

smelters. Mercury levels are monitored in mink and otter in the Rat-Burntwood River system. This program is being expanded to Southern Manitoba.

Results: This is an ongoing study; interim results are available through Manitoba Environmental Management.

6. NORTHWEST TERRITORIES

Terrestrial Sensitivity Mapping
Northwest Territories
Preparations were made to issue a contract for this work early in 1984.

Results: For further information, contact the Pollution Control Division, Government of the Northwest Territories.

7. ENVIRONMENT CANADA

7.1 EMISSIONS AND CONTROL TECHNOLOGY

Emission Control Review
The Environmental Protection Service has completed several studies under contract to the private sector which deal in whole or part with acid gas emission controls and their related costs as follows:

i) Characterization and Treatment of Emissions from a Mining Oil Sands Complex, March, 1983.

ii) Pollution Abatement Review with respect to Heavy Crude Oil Upgrading, Synthetic Crude Use at Refineries, Increased Natural Gas Processing and Liquified Natural Gas Facilities, August, 1983.

iii) Environmental Implications of Coal Gasification/ Liquification Technologies in Canada, March, 1983.

iv) Investment and Operating Cost Study - Sulphur Recovery Facilities, Natural Gas Processing Industry, March, 1983.

v) Air Pollution Abatement Study for Petroleum Refineries, September, 1983.

vi) Final Report on the Cost of Acid Gas Emissions for Canadian Utilities, April, 1983.

vii) Development of Recommended Water, Wastewater and Solid Waste Management Practices for FGD equipped Coal-Fuelled Power Generating Stations, March, 1983.

viii) Environmental Codes of Practice for Steam Electric Power Generation: Code 1 - Siting Phase (early 1984); Code 2 - Design Phase.

The above reports were commissioned under contract to the Environmental Protection Service and their contents are the responsibility of the authors.

Reports: The information gathered has been summarized in final reports. Further information is available through the Environmental Protection Service, Environment Canada, Edmonton.

7.2 AIR QUALITY AND DEPOSITION

Air and Precipitation Network (APN) Station: Cree Lake
Cree Lake, because it is remote from sources of industrial emissions, is an excellent site for the measurement of regional air quality precipitation chemistry. The site started operation in 1982.

Results: The data are available through the Atmospheric Research Directorate, Atmospheric Environment Service, Downsview.

Acid Deposition Model for Western Canada
Trajectory model techniques developed by the Atmospheric Environment Service for eastern North America have been applied to determine acid deposition patterns in western Canada. Work is continuing to use a broader data base to confirm initial results.

Report: Final report is available through the Atmospheric Environment Service, Edmonton.

Canadian Network for Sampling Precipitation (CANSAP)
Stations in this network have samplers which open only during precipitation events. Samples are removed daily and analysed on a monthly basis for pH, conductivity, sulphate, nitrate, chloride, ammonium, potassium, sodium, magnesium and calcium. The network includes the following distribution in western Canada:

Manitoba: Bisset
Dauphin
The Pas
Alberta: Fort McMurray
Edson
Coronation
Lethbridge
Rocky Mountain House
Saskatchewan:
Cree Lake
Kindersley
Wynyard
British Columbia:
Fort St. John
Fort Nelson
Vancouver
Terrace
Prince George
Kelowna
Port Hardy
Revelstoke
Northwest Territories:
Hay River
Inuvik
Fort Reliance
Mould Bay
Yukon: Whitehorse

Conversion of the CANSAP network in Manitoba to the Canadian Air and Precipitation Monitoring Network (CAPMON) resulted in the following changes, effective September, 1983:
Bisset gauge moved to Island Lake

Dauphin gauge moved to McCreary
The Pas gauge discontinued.

Results: Data summaries are published routinely and are available from the Atmospheric Environment Service, Vancouver, Edmonton, Winnipeg.

Precipitation Chemistry on the British Columbia Coast
A network of 13 precipitation sampling stations extending from the west coast of Vancouver Island eastward across the Strait of Georgia to the lower Fraser Valley was operated in 1983. Preliminary results from the analysis of 23 storms show that precipitation from storms which arrive from the Pacific Ocean without traversing a polluted area has an average pH of 5.3 over the outer British Columbia coast. Precipitation associated with air mass trajectories from the Puget Sound area, south of Vancouver, has an average pH of 4.9 over the southern Strait of Georgia.

In the lower Fraser Valley, which is predominantly an agricultural area with a large dairy industry, pH measurements were higher and there was a marked increase in concentration of the ammonium ion.

Reports: A report is available through the Atmospheric Environment Service, Vancouver.

Other reports available are:
Lower Mainland Precipitation Chemistry Data;
Sampling of Snow Packs for Chemical Analysis in Southern British Columbia;
An Event Rain Sampler for Precipitation Chemistry;
Acid Rain on the West Coast of British Columbia.

Precipitation Event Sampling - Port Hardy and Terrace
Precipitation samples collected at Port Hardy and Terrace will be analyzed to relate precipitation chemistry to regional industry activity. Preliminary results indicate that sulphate concentrations in precipitation at Port Hardy are related to regional forest products processing activities.

Report: A report on the results of this study is available through the Atmospheric Environment Service, Vancouver.

Pacific Coastal Area Precipitation Sampling
The comparative analysis of

precipitation chemistry data from the Institute of Ocean Sciences and the MIC collector identified some problems in achieving a consistent ion balance. The project to select a collector for precipitation sampling on shipboard has therefore been discontinued.

Results of the snow sampling network on Vancouver Island and the lower mainland have been evaluated and a report will be finalized early in 1984.

Results: Further information is available through the Atmospheric Research Directorate, Atmospheric Environment Services, Downsview, and the Institute for Ocean Sciences, Sidney.

7.3 SURFACE WATERS

Water Chemistry Sampling - Northwest Territories
The Inland Waters Directorate, Environment Canada, monitors water quality at 6 river sites in the Northwest Territories.

Results: Data summaries are available from the Inland Waters Directorate, Environment Canada, Regina.

7.4 SOILS AND GEOLOGY

Pollutant Effects on Soil Biological Processes
Studies are being carried out on the effects of metal ions on decompositional processes associated with forest soils. Preliminary results indicate that in boreal forest soils enzymes may have a higher resistance to metal ions than was previously thought. Comparisons are being made between contaminated soils taken from areas adjacent to point emitters and control soils treated with metal salts in laboratory situations.

Results: Preliminary results are available from the Northern Forest Research Centre, Environment Canada, Edmonton.

Soil and Bedrock Sensitivity Mapping for Yukon
Preliminary sensitivity maps of soils and bedrock to acid deposition have been prepared for Yukon.

Results: Available from Lands Directorate, Environment Canada, British Columbia.

7.5 VEGETATION

Physiological and Biochemical Effects of Simulated Acid Rain on Native Boreal Species
Studies are being carried out under laboratory conditions to determine the dose - response relationship of native species to simulated acid rain.

Assessments are being made of the physiological changes that are symptomatic of acid rain induced injury.

Results: Results available from the Northern Forest Research Centre, Environment Canada, Edmonton.

7.6 HEALTH

Selenium Deficiency in Food
Changes in elemental composition (selenium in particular) are being measured in lots of two wild herbivore food plants being exposed twice weekly to 500 mL of 0.0, 7.5 and 15.0 ppm sulphate solution as simulated rain. Zero and 0.1 ppm Selenium as Iron III selenite fertilizer applications were made to the experimental soils. A final year of this experiment has been completed.

Report: A progress report is available from the Canadian Wildlife Service, Environment Canada, Edmonton.

Effects of SO_2 Emissions on Selenium Content in Vegetation
A study to determine the effects of SO_2 on elemental composition (selenium in particular) of vegetation in the vicinity of sour gas plants was finished in 1983-84.

Report: A progress report is available from Canadian Wildlife Service, Environment Canada, Edmonton.

8. FISHERIES AND OCEANS CANADA

8.1 SURFACE WATERS

Effects of Pollutant Deposition on Fish and Other Aquatic Organisms

Research programs are designed to detect the effects of atmospheric deposition of pollutants on fish and other aquatic organisms, to investigate the fundamental mechanism of affected life processes, and to evaluate limnological processes involved in buffering oligiotrophic lakes. These programs are conducted in lakes impacted by base-metal smelters, in experimentally acidified lakes and in the laboratory. Emphasis is placed on establishing the priority of sulphuric and nitric acids, on determining the contribution of metal contamination and toxicity to adverse effects on fisheries, and on developing sensitive indicators of stress induced by the atmospheric deposition of pollutants on fish and other aquatic organisms.

Results: Data available from Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Manitoba.

Fisheries Related Surface Water and Snowpack Baseline Chemistry Monitoring in British Columbia and the Yukon

Surface water and snowpack sampling has been carried out on Pacific Salmon watercourses in the British Columbia interior, lower mainland, Vancouver Island, north coast, Queen Charlotte Islands and in the Yukon. These data will provide a benchmark against which long term trends in acidification and buffering capacity will be assessed. In documenting the sensitivity of watersheds, the Department will be better equipped to assess development proposals with the potential to acidify surface waters. These studies are being conducted by Fisheries and Oceans Canada with cooperation from the International Pacific Salmon Fisheries Commission.

Results: Data available from the Water Quality Unit, Habitat Management Division, Fisheries and Oceans, Canada, Vancouver.

9. JOINTLY MANAGED ACTIVITIES

9.1 EMISSIONS AND CONTROL TECHNOLOGY

Air Pollution Emission Inventory
An inventory of point sources of common air pollutants has been prepared for 1980. The report is prepared every two years and includes sulphur oxides, nitrogen oxides, carbon monoxide, hydrocarbons and particulates.

Results: Emission inventory information is available from the Environmental Protection Service, Environment Canada, Edmonton.

Vehicle Emission Testing in Manitoba
Environment Canada cooperated with Manitoba Environmental Management Division to complete a one-week automobile emission testing clinic in Winnipeg during Canadian Environment Week, 1983. The potential benefits of incorporating emission tests as a standard part of a routine vehicle inspection program were investigated.

Report: A report is available through the Mobile Sources Division, Environment Canada, Ottawa, or Environment Canada, Winnipeg and Edmonton.

9.2 AIR QUALITY AND DEPOSITION

National Air Pollution Surveillance
NAPS Stations are operated cooperatively by federal and provincial agencies in each of the western provinces. Measurements include sulphur dioxide, nitrogen oxides, carbon monoxide, ozone, and particulates.

The distribution is as follows:

Manitoba:	Winnipeg	5
	Brandon	1
Saskatchewan:	Regina	3
	Saskatoon	2
	Moose Jaw	1
	Prince Albert	1
Alberta:	Edmonton	7
	Calgary	5
	Red Deer	1
	Medicine Hat	1
	Lethbridge	1
British Columbia:	Greater Vancouver Regional District	7
	Prince George	1
	Victoria	1
	Kamloops	1
	Penticton	1
Northwest Territories:	Yellowknife	1
Yukon	Whitehorse	1

Results: Data summaries are available from provincial environmental departments or Environmental Protection Service, Environment Canada, at major centres.

10.1 BRITISH COLUMBIA

Exposing Eggs, Young Fish and Adults
The effects of exposing eggs, young fish and adults (before sexually active) to acid conditions, both for long and short terms started in 1981. The project is continuing.

Results: For further information contact the Department of Biological Sciences, Simon Fraser University.

Effects of Acidification in Insect Life
Effects of acidification on insect life in aquatic systems started May, 1981. The project is continuing.

Results: For further information contact the Department of Biological Sciences, Simon Fraser University.

Response of Zooplankton and Phytoplankton
A project to determine the response of zooplankton and phytoplankton to artificial acidification and fertilization.

Report: A thesis by David Marmorek was completed in 1983; contact the Institute of Animal Research Ecology, University of British Columbia.

Effects of Acidification on Stream Organisms
A project to determine the effects of acidification on stream organisms and to determine the mechanisms for change that take place in the community. Started in 1982, this project is continuing.

Results: For further information contact the Institute of Animal Resource Ecology, University of British Columbia.

10.2 ALBERTA

Analysis of Sulphate Wet Deposition in Canada during the Intensive Sulphate Study, August, 1976.
Regional scale spatial and temporal variability of the sulphate component of both particulate and precipitation samples will be investigated for the ground stations used in the Intensive Sulphate Study. Determination of the scavenging ratio and its relationship to regional meteorology is included.

Report: A conference

presentation report is available from Dr. E. Lozowski, Division of Meteorology, University of Alberta.

Sulphur and Precipitation
To test the correlation between sulphur emissions and reduced crop damage in central Alberta due to hail, an airborne measurement project was initiated in 1982. Its purpose is to determine: (1) the transport and dispersion of emissions from isolated gas plants; (2) the concentration of gaseous and particulate sulphur and nitrogen compounds in the inflow of thunderstorms; and, (3) the concentration, chemical composition, and size distribution of cloud water droplets in thunderstorms.

Report: An interim report will be available late in 1984 from the Atmospheric Sciences Department, Alberta Research Council.

Biomonitoring the Effects of Atmospheric Sulphur Dioxide on Dominant Tree Species near the Suncor Plant
A total of 40 permanent biological sample plots have been established within eleven kilometres of the Suncor oil sands plant near Fort McMurray. Environmental components being investigated include: soil pH and texture; visible foliar symptoms attributable to sulphur dioxide; and plume impingement areas.

Report: Initial results are available from T. Shopik, Environmental Affairs Suncor Inc.

Qualitative Damage Assessment of Revegetation on Reclamation Areas 1979-1980
A description of transient chronic and acute symptoms attributable to sulphur dioxide has been made. All species present on reclaimed lands on the Suncor oil sand lease are examined each August.

Report: Initial results are available from T. Shopik, Environmental Affairs Suncor Inc.

The Environmental Impact Potential of Suncor Power Plant Fly Ash
Simulation of different fly ash application rates were conducted on vegetation plots near Fort McMurray in 1977. Plant tissue and soil analyses were then performed in subsequent years to determine the impact due to the fly ash.

Report: A final report is available from P. Thanawala, Environmental Affairs Suncor Inc.

Proposed Emission Guidelines for Fossil Fuel Fired Thermal Power Generating Plants in Alberta

In response to proposed new emission guidelines for thermal generating power plants in Alberta, a series of studies were initiated to assess the impact of these guidelines on the environment and the consumer. With participation from both industry and government, this program will examine the feasibility of using existing technology to meet the emission requirements. Commencing in 1984, the latest project will examine the use of the natural variability in the chemical and physical properties of coal to control the short term averaging of emissions.

Report: All initial and subsequent reports are available from the Environmental Planning Division of Alberta Power Limited.

Trace Constituent Research Program

The distribution of trace constituents among various release pathways of selected coal fired power generating stations will be investigated. Trace elements, organic contaminants and radionuclides in addition to major emission components are included. The effects of these emissions on the atmospheric, aquatic and terrestrial environments at one generating station will be evaluated.

Report: A final report will be available early in 1984 from the Environmental Planning Division of Alberta Power Limited.

Modelling of Long-Range Transport and Acid Deposition

The development of a flexible modelling system to assess the long-range transport and acidic deposition on sensitive receptor areas has been initiated. A data base of emission, meteorological and receptor data which can easily be updated is included.

Report: A final report will be available early in 1984 from the Environmental Planning Division of Alberta Power Limited.

10.3 SASKATCHEWAN

Reindeer Lake Event Precipitation Chemistry Study
Event collection of precipitation was continued in 1983 near Southend, Saskatchewan on Reindeer Lake. The rain was analyzed for pH, and major ions of sulphate and nitrate.

Report: Further information is available from the Saskatchewan Research Council.

Response of Some Saskatchewan Forest Species to Acidic Deposition
Preliminary laboratory investigations have been conducted on jack pine and white spruce to determine visible damage symptoms and needle chlorophyll concentration.

Results: Further information available from the Saskatchewan Research Council.

Laboratory Studies on Acidic Deposition
Detailed organic acid analyses are being conducted on rain and snow samples from northern Saskatchewan. Many of the samples collected in this area have pH levels below 5.6 This study will attempt to identify the reasons for the acidity since sulphate and nitrate levels are quite low.

Results: Further information available from the Saskatchewan Research Council.

The Nature and Properties of Current and Potential Acidity of Soils in Saskatchewan
The acidic characteristics of a group of 20 soil samples, taken from various locations throughout western Saskatchewan, were investigated. The particle size distribution of soil acidity was looked at for four soil series. The influence of liming on soil properties and nutrient availability was studied and the chemistry of selenium in soils in relation to liming was also investigated.

Results: Further information available from the Saskatchewan Research Council and the Soils Department, University of Saskatchewan.

Chemical Studies of Acid Rain Impacts
The Chemistry Department, University of Regina, collected approximately 70 samples of snow, rain and lakes primarily in southern Saskatchewan and

are analyzing these samples for pH, hardness, alkalinity, cadmium, lead and aluminum. The purpose of this study is to experiment with techniques which may improve the analytical procedures for metals in these types of samples. Lake sediment samples were also collected and acidified to assimulate the acidification process due to acid precipitation in order to study the release of metals from the sediments.

Results: Further information available from the Chemistry Department, University of Regina.

Saskatchewan Power Corporation Monitoring Activities at Poplar River (Coronach) and Boundary Dam (Estevan) Power Stations
Two stations continuously monitoring ground level concentrations of sulphur dioxide are located at the U.S. border. One is located south of the Poplar River Power Station and the other south of the Boundary Dam Power Station. Emissions at the Poplar River Power Stations are continuously monitored for opacity, sulphur dioxide and nitrogen oxides concentrations. Surface waters in the vicinity of the Poplar River and Boundary Dam Power Stations are monitored at 10 sites and analyzed for pH, sulphates, nitrates, alkalinity, etc.

Results: Further information available from the Saskatchewan Power Corporation and the Air Pollution Control Branch, Saskatchewan Environment.

Saskatchewan Power Corporation Agricultural Monitoring Program - Poplar River Power Plant
As part of this program the Saskatchewan Research Council measured sulphation levels at 34 sites. Rainfall samples were collected and analyzed for pH, sulphate, nitrate, calcium, magnesium, potassium, sodium, bicarbonate and specific conductance.

Results: Further information available from Saskatchewan Power Corporation.

Low NO_x/SO_x Burners
Saskatchewan Power Corporation is conducting a study on the effectiveness of burners designed to reduce the quantities of nitrogen oxides and sulphur dioxides being emitted from coal-fired power plants. The program is in its initial stages.

Results: Further information available from the

Director, Coal and Gas Research, Research and Development Centre, Saskatchewan Power Corporation.

Leaching from Power Plant Emissions
A variety of experimental methods are being studied by Saskatchewan Power Corporation in order to better evaluate leaching characteristics of coal ashes. Ash constituents that could cause environmental problems are being identified. Methods of treating difficulties arising from ash leachates are being examined.

Results: Further information available from the Director, Coal and Gas Research, Research and Development Centre, Saskatchewan Power Corporation.

Monitoring at AMOK Ltd. Uranium Mine, Cluff Lake.
The average sulphation levels are determined on a monthly basis at 23 sites around the mine using lead peroxide plates.

Results: Data summaries are available through Amok Ltd. and Saskatchewan Environment.

Monitoring at Eldor Mines, Uranium Mine, Rabbit Lake
Eldor Mines continuously monitor ground level concentrations of sulphur dioxide at one site.

Results: Data summaries are available through Eldor Mines and Saskatchewan Environment.

10.4 MANITOBA

Monitoring in Thompson
A permanent station continuously monitoring ground level concentrations of sulphur dioxide is located to the north west of the non-ferrous smelter facility, between the plant and the town. A mobile station is used during the spring, summer and early fall (during the growing season) to provide sulphur dioxide concentrations in other directions. In addition to measuring ground level concentrations of sulphur dioxide, there is a meteorological program to regulate the smelter production so that acceptable concentrations of sulphur dioxide are maintained under different dispersion conditions.

Satellite imagery is being used to detect and map vegetation changes in the Thompson area. Maps have been prepared for

1973 and 1978 and one for 1983 has been commissioned.

Results: Data summaries are available through INCO Limited.

Monitoring in Flin Flon
Three stations continuously monitoring ground level concentrations of sulphur dioxide are located within 4.8 kilometres of the 250 metre high main stack of the non-ferrous smelter facility. A high volume sampling program measures airborne particulate levels and determines heavy metal concentrations at two sites located 0.8 and 4.8 kilometres from the main stack. Dustfall is measured in the vicinity of the non-ferrous smelter facility at two locations 0.5 and 1.6 kilometres from the main stack to determine particulates for total solids, dissolved solids and ignition loss.

Results: Data summaries are available through Hudson Bay Mining and Smelting Company Limited.

Monitoring in St. Boniface
Three stations continuously monitoring sulphur dioxide are located in the three directions of the prevailing winds, and around the St. Boniface Refinery.* One of the sites is equipped to determine hydrogen sulphide also. Wind speed and direction equipment report hourly wind averages on a 24 hour per day basis.

Results: Data summaries are available through Shell Canada Limited.

*Please note:
This refinery was shut down in September, 1983, and the monitoring was discontinued at that time.

11. ADDRESSES FOR FURTHER INFORMATION

BRITISH COLUMBIA

British Columbia Ministry of Environment
Parliament Buildings
Victoria, British Columbia
V8V 1X5

Department of Biological Sciences
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Institute of Animal Resource Ecology
University of British Columbia
2075 Wesbrook Mall
Vancouver, British Columbia
V6T 1W5

ALBERTA

Alberta Environment
Pollution Control Division
6th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, Alberta
T5K 2J6

Alberta Environmental Centre
Toxicology Group
Animal Sciences Wing
Bag 4000
Vegreville, Alberta
T0B 4L0

Alberta Environmental Centre
Environmental Technology Wing
Bag 4000
Vegreville, Alberta
T0B 4L0

University of Alberta
Division of Meteorology
Department of Geography
3-32 H.M. Tory Building
Edmonton, Alberta
T6H 2H4

Alberta Environment
Technical Development Branch
Earth Sciences Division
P.O. Box 3014
Cousin's Building
Lethbridge, Alberta
T1J 4B3

Alberta Research Council
Atmospheric Sciences Department
7th Floor, Terrace Plaza
4445 Calgary Trail South
Edmonton, Alberta
T6H 5R7

Suncor Inc.
Oil Sands Division
Environmental Affairs
P.O. Box 4001
Fort McMurray, Alberta
T9H 3E3

Alberta Power Limited
Environmental Planning
10040 - 104 Street
Edmonton, Alberta
T5J 2V6

SASKATCHEWAN

Saskatchewan Environment
5th Floor, 1855 Victoria Avenue
Regina, Saskatchewan
S4P 3V5

Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan
S7N OX1

Soils Department
University of Saskatchewan
Saskatoon, Saskatchewan
S7N OX1

Saskatchewan Power Corporation
2025 Victoria Avenue
Regina, Saskatchewan
S4P OS1

Amok Ltd.
817 - 825 45th Street West
P.O. Box 9204
Saskatoon, Saskatchewan
S7K 3X7

Eldor Mines
P.O. Box 2070
Saskatoon, Saskatchewan
S7K 3X7

Chemistry Department
University of Regina
Wascana Parkway
Regina, Saskatchewan
S4S OA2

MANITOBA

Manitoba Environment and Workplace
Safety and Health
Environmental Standards and Studies
Box 7, Building 2
139 Tuxedo Avenue
Winnipeg, Manitoba
R3N OH6

Hudson Bay Mining and Smelting
Company Ltd.
Supervisor Environmental Control
Flin Flon, Manitoba
R8A 1N9

INCO Limited
Director
Safety, Health and Environment
Manitoba Division
Thompson, Manitoba
R8N 1P3

Shell Canada Limited
Supervisor Environmental Control/Lab
St. Boniface Refinery
P.O. Box 130, St. Boniface
Winnipeg, Manitoba
S2H 3B4

NORTHWEST TERRITORIES

Pollution Control Division
Renewable Resources
Government of the Northwest Territories
Yellowknife, Northwest Territories
X1A 2L9

FEDERAL AGENCIES

Atmospheric Environment Service
Atmospheric Research Directorate
4905 Dufferin Street
City of North York
Downsview, Ontario
M3H 5T4

Atmospheric Environment Service
Scientific Services Division
Central Region
10th Floor, Room 1000
Winnipeg, Manitoba
R3C 3V4

Atmospheric Environment Service
Scientific Services Division
Western Region
Argyll Centre
6325 - 103 Street
Edmonton, Alberta
T6H 5H6

Atmospheric Environment Service
Scientific Services Division
Pacific Region
700 - 1200 West 73rd Avenue
Vancouver, British Columbia
V6P 6H9

Environmental Protection Service
Western Region
Room 804, 9942 - 108 Street
Edmonton, Alberta
T5K 2J5

Environmental Protection Service
Pacific Region
3rd Floor, Capilano 100
Park Royal
West Vancouver, British Columbia
V7T 1A2

Environmental Protection Service
Mobile Sources Division
Ottawa, Ontario
K1A 1C8

Environmental Protection Service
Mobile Sources Division
Ottawa, Ontario
K1A 1C8

Canadian Wildlife Service
Environment Canada
9942 - 108 Street
Edmonton, Alberta
T5K 2J5

Freshwater Institute
Department of Fisheries and Oceans
501 University Crescent
Winnipeg, Manitoba
R3T 2N6

Inland Waters Directorate
Environment Canada
1901 Victoria Avenue
Regina, Saskatchewan
S4P 3R4

Institute of Ocean Sciences
9860 West Saanich Road
Box 6000
Sidney, British Columbia
V8L 4B2

Northern Forest Research Centre
Environment Canada
5320 - 122 Street
Edmonton, Alberta
T6H 3S5

Department of Fisheries and Oceans
1090 West Pender Street
Vancouver, British Columbia
V6E 2P1

Lands Directorate
Environment Canada
506 West Burnside Road
Victoria, British Columbia
V8Z 1M5